MULTIVARIATE ANALYSIS OF PEST INCIDENCE IN POLYCULTURE AGRO-ECOSYSTEMS IN FAYOUM, EGYPT

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Abstract :

The field experiment explained in this paper was meant to study the effect of polycultural practices in Fayoum agro-ecosystems, on pest incidence. Application of Principal Components Analysis, Correspondence Analysis and Ascending Hierarchic Classification techniques to data of the present study shows that differences can be detected more accurately than by either the *t*-test or by ANOVA.

Key-words : Fayoum - arthropod pests - polyculture - wheat - Trifolium.

Résumé :

L'analyse Multifactorielle de l'Abondance des Ravageurs dans un Agro-système de Polyculture au Fayoum, Egypte.

Une parcelle dans le Gouvernorat de Fayoum, Egypte, a été cultivée entre décembre 1992 et mai 1993, en blé, en trèfle alexandrin et en blé et trèfle en polyculture, à raison d'un feddan pour chacune de ces cultures (1 fed. = ca. 4400m^2). La polyculture a été en lignes parallèles des deux espèces cultivées, au milieu des deux monocultures. Aucun insecticide n'a été utilisé. Les arthropodes ravageurs ont été recensés tous les 15 jours pour 90 jours. Les deux premières visites ont été négatives, tandis que les suivantes ont montré un total de 11 espèces d'arthropodes ravageurs et une seule espèce prédatrice. L'abondance des ravageurs dans la polyculture était moins importante que dans les

Proceedings of the International Meeting "Ecology and Statistical Methods", NIORT 1994

monocultures. N'empêche que certaines espèces étaient plus abondantes dans la polyculture. Les méthodes statistiques conventionnelles ont montré des différences significatives pour la totalité des ravageurs entre les deux traitements seulement dans le cas du trèfle et aussi en ce qui concerne le laps de temps. Pourtant, l'analyse factorielle de correspondances a montré, elle, des différences beaucoup plus subtiles en ce qui concerne les traitements et les dates de recensement à la fois. Elle a indiqué, de plus, les espèces des ravageurs les plus caractéristiques en fonction de ces deux facteurs, et que l'effet du temps est plus remarquable dans le cas du blé que dans celui du trèfle. Ceci est probablement dû à la différence morphologique entre ces deux espèces cultivées.

Mots-clés : Fayoum - Arthropodes ravageurs - Polyculture - Blé - Trèfle alexandrin.

Introduction

The field experiment explained in this paper was meant to study the effect of polyculture (mixed cropping) practices advocated in recent attempts to improve environmental conditions by reducing the use of pesticides, as one method in integrated pest management. The idea is that when plants are mixed, there is a lower chance for pests to move from one plant to another plant of the same species, as it is hindered by another plant of another species. Mixed cropping may also increase the proportion of predators to pests, and effect favourable changes in biodiversity.

Vegetation texture (i.e. plant density, species diversity, and structural composition) may influence the abundance of a herbivore (agricultural. pest) by affecting its movement, altering the suitability of host plants (Coll & Bottrell 1994). The effect of polyculture (mixed cropping) in reducing agricultural pests is well documented (Jackai *et al.*, 1985; Suharto, 1989; Ajayi, 1990; Akhtar & Allam, 1991; Helenius, 1991; Andow, 1991).

Material and Methods

The experiment was conducted at Basouniya village, Fayoum district, the Governorate of Fayoum (Middle Egypt), during the period between December 1992 and May 1993. An area of 3 feddans (one feddan = 1.038 acre) was

selected and divided into three equal parts (one feddan each). In the first part Giza 157 variety of wheat (*Triticum vulgare*) was cultivated. Egyptian clover (*Trifolium alexandrinum*) was cultivated in the third part as monoculture. The second part (in the middle) was used to cultivate both wheat and clover as polyculture in alternating rows using a seeder at regular intervals, while clover was sown by irregular broadcasting. Wheat was planted in ridges and clover in the grooves in between. Wheat was planted first followed by clover just after the first time of irrigation, at the same time with the clover of its own part (monoculture). Normal agricultural practices were followed and no insecticides were used.

Sampling was done by collecting 40 parts of the growing plants, at each visit, at random. Collection of plant parts was from the top upper part of the plant in the case of clover and from the top three ripe leaves in the case of wheat (Anonymous 1987). Visits were carried out at 15-day intervals for a total period of 90 days from sowing to harvesting. The pests as well as predators and their numbers were recorded for each sample and the mean number of individual animals per plant was recorded (n=40 for each crop, for each treatment, and for each visit).

Data obtained were treated by conventional and also the advanced multivariate statistical methods. The former include *t*-test and 2-way ANOVA, and the latter Principal Components Analysis (PCA) and Correspondence Analysis (CA), coupled with Ascending Hierarchic Classification (AHC). AHC was applied to the result of each of PCA and CA. The multivariate statistical methods used in the present study especially CA are better tools for displaying the rows and columns of a data matrix as a point in dual low-dimensional vector space than histograms (Greenacre 1984). In this respect CA is more useful than PCA. For detailed explanation of each of PCA and CA methods see Ludwig & Reynolds (1988) and for AHC see Roux (1985). The computer calculations for PCA, CA, and AHC were carried out at Cairo University using DATAVISION programme 1.2 (Roux 1987) developed for APPLE IIe in Basic.

Results and Discussion

A total of 12 species, representing seven families of arthropods were recorded (Table 1).

Table (1a) : Number of arthropods recorded (ind./plant) in wheat mono- and polycultures.

Taxa	Wheat monoculture					Wheat polyculture				
	20-Mar	5-Avr	21-Avr	7-Mai	14-Mai	20-Mar	5-Avr	21-Avr	7-Mai	14-Mai
Frankiniella tritici	1.1	0.2	10.9	8.4	18.2	0.8	0.7	4.8	5.5	8.3
Toxoptera graminum	1	0.6	0	0.5	0	0.5	0	0	0.4	0
Tetranychus spp.	0	0	0.3	1.4	0	0	0	0	0.7	0.8
Trachelus tabidus	0	0	0	0.1	0.1	0	0	0	0.7	0
Coccinella undecipunctata	0	0	0	0	0	0	0	0	0.3	0.1
Calandra oryzae	0	0	0	1	0.5	0	0	0	0	0.1

Table (1b) : Number of arthropods recorded (ind./plant) in clover mono- and polycultures.

Taxa	Clover monoculture					Clover polyculture				
	20-Mar	5-Avr	21-Avr	7-Mai	14-Mai	20-Mar	5-Avr	21-Avr	7-Mai	14-Mai
Tetranychus telarius	0	0	0	0.6	0	0	0	0.4	0.6	0.7
Liriomyza congesta	0.9	0.6	4.4	4.3	3.6	1	0.4	2.6	0.7	2
Empoasca decipiens	0.8	0.6	1.7	1.5	0.7	0.4	0	1.1	1.5	0.9
Caliothrips sudanensis (leaves)	0.5	0.3	0.7	0.4	0	0.4	0	0.6	0.6	0.6
Caliothrips sudanensis (inflor.)	0.8	0.8	0.7	0.7	0.5	0.5	0.2	1.9	0.7	0.6
Phytonomus brunneipennis (larvae)	1.1	0.4	4.8	2	2.7	0.6	0	3.1	0.6	1.1
Phytonomus brunneipennis (adult)	0	0	0	0	0	0	0	0.5	0	0
Aphis laburni	0.4	0.1	1.6	0.3	1.2	0.4	0.5	0.9	0.2	0.7

Table (2) : 2-way ANOVA between sampling

Crop	Source	SS	df	MS	F-ratio
Wheat	Dates	53.49	9	5.944	1.07 ns
	Species	272.13	5	54.426	9.81 ***
	Error	249.55	45	5.546	
	(Total)	575.17	59		
Clover	Dates	21.36	9	2.37	4.27 **
	Species	26.78	6	4.64	8.03 ***
	Error	30.03	54	0.56	
	(Total)	78.18	69		

Five species were recorded in both mono- and polyculture wheat, but *Coccinella* (a predator) was recorded only in late stages of polyculture wheat. The total number of pest individuals for the whole period was 44.3 ind./plant for wheat monoculture and only 23.3 ind./plant in polyculture (mixed with clover). In the case of clover, pests on both leaves and inflorescences for the whole period were 39.6 ind./plant for monoculture and only 26.9 ind./plant in polyculture (with wheat). No predators were recorded with clover. All samples taken on visits before 20 March were void. In some cases there were more pests in poly- than in monoculture, such as *Trachelus* in the case of wheat, and *Tetranychus* and *Caliothrips* in the case of clover.

Fig. (1) shows fluctuations in the total number of insect pests per plant recorded during the sampling dates with positive results. It is noticed that higher numbers of the total insect pests was recorded at the third positive sampling date (21 April 1993).

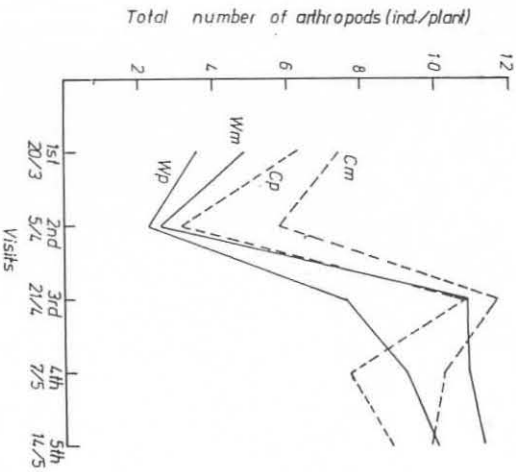

Figure 1 : Total number of arthropods pests recorded during the period of the present study. C, clover; W, wheat; m, monoculture; p, polyculture. Visits refer to those with positive results.

The *t*-test of totals shows that differences between the total number of insect pests recorded in mono- and polycultures are not significant in the case of wheat and significant in the case of clover. Analysis of variance shows that differences between sampling dates are not significant in the case of wheat mono- and polycultures, but differences in the mean number of insect pests are

significant (Table 2). In the case of clover mono- and polycultures, significant differences are obtained between each of sampling dates and species.

Application of CA and AHC techniques to data of the present study for wheat (Fig. 2a) and clover (Fig. 2b) shows that there are differences between sampling dates and the insect pests associated with each of mono- and polycultures.

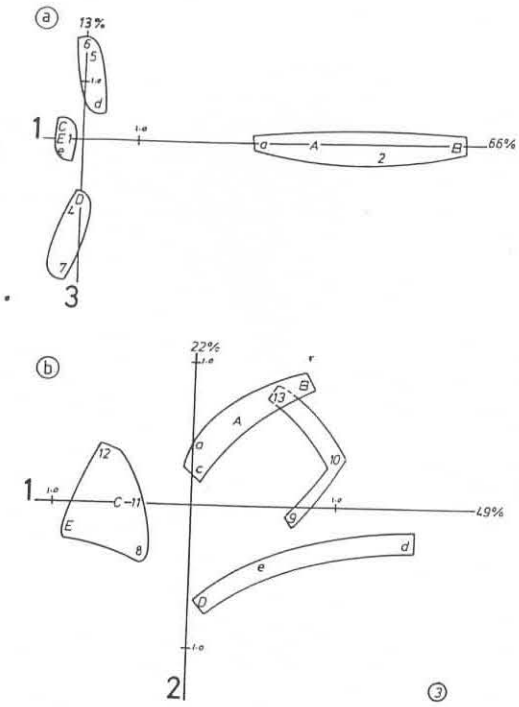

Figure 2 : Graphical representation of the application of CA and AHC methods to data of Table (1) for wheat (Fig. 2a) and clover (Fig. 2b). Letters A-E; sampling dates: A, 20 Mar.; B, 5 Apr.; C, 21 Apr.; D, 7 May; E, 14 May. Capital letters are for monoculture, small letters are for polyculture. Taxa, 1-13: 1, *Frankiniella tritici*; 2, *Txoptera graminum*; 3, *Tetranychus telarius*; 4, *Tetranychus* spp.; 5, *Trachelus tabidus*; 6, *Coccinella undecimpunctata*; 7, *Calandra oryzae*; 8, *Liriomyza congesta*; 9, *Empoasca decipiens*; 10, *Caliothrips sudanensis*; 11, *Phytonomus brunneipennis* (larvae); 12, *Aphis laburni*; 13, *Phytonomus brunneipennis* (adult).

Results obtained from PCA application are the same as those obtained in the case of CA. In Fig. 2a, 66% of the total variance is associated with the first axis and 13% with the third one. The first axis separates early positive sampling dates of both mono- and polyculture wheat from the late positive sampling dates each with its own characteristic taxa The vertical axis (the third) separates taxa of the fourth positive sampling date (the one before last), in mono- and polycultures. *Toxoptera graminum* is present in the early positive sampling dates in both treatments. *Trachelus tabidus* and *Coccinella undecimpunctata* are associated with the fourth positive sampling date in wheat polyculture and *Tetranychus* spp. and *Calandra oryzae* are associated with monoculture. In Fig. 2b, 49% of the total variance is associated with the first axis and 22% with the second one. The first axis separates more or less late stages of monoculture from late stage of polyculture, meaning that the effect of polyculture is more evident in late stages. The vertical axis separates early from late stages. This factorial analysis shows that the effect of time is stronger in the case of wheat than in the case of clover. This is perhaps because of differences in plant texture and structural composition (Coll & Bottrell 1994) between wheat and clover cultivation.

Results of the present study show that the intercropping of wheat and clover lower the number of insect pests than in each of wheat and clover monocultures.

Application of PCA, CA, and AHC techniques to data of the present study shows that differences can be detected more accurately than by either the *t*-test or by ANOVA.

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